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ABSTRACT

An experiment was conducted to determine the validity of the theory that language-disordered children use the same strategies in acquiring phonological phenomena, in this case consonant clusters, as normal children do but at a later age. In acquiring productive use of consonant clusters, normal children go through three stages: (1) reduction or deletion of one consonant of the cluster; (2) splitting of the cluster with a vowel (epenthetic), usually schwa, inserted between two consonants; and (3) elongation of the cluster before final adult productive use of the cluster. The experiment studied the output of 6-to 8-year-old language-disordered children against that of 2-to 5-year-old normal children in producing 56 monosyllabic English words. Twenty-six words had an initial consonant cluster and 30 had single initial consonants. Results show that cluster production of normal children matched that of the disordered children in production time, with a few exceptions. When compared with adult production time, the children's was much longer. The duration time for the normal and the disordered children was attributed to the insertion of the epenthetic vowel. Disordered children, however, use the strategy of elongation longer than normal children do, and also use productive strategies not used by the normals. (PJM)

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Phonological acquisition in language disordered and normal children:
Duration as a productive strategy *

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The acquisition of the productive use of initial consonant clusters in normal children has been shown to progress through the following stages: (1) reduction, or deletion of one consonant of the cluster, (2) splitting of the cluster with an epenthetic vowel, usually /ə/, (3) elongation of the cluster, and finally adult-like production. These phenomena have been documented Allerton (1976), Greenlee (1973, 1974), Gilbert and Purves (1977), Ingram (1976), Menyuk and Klatt (1975), Kornfeld (1971) and Smith (1973). Gilbert and Purves suggest that the production of consonant clusters may be controlled by a timing-dominant mechanism which has been described by Ohala (1970), and which is not well developed in young children. They hypothesize that this immature system may account for the deletion, splitting, and elongation processes found in normal children.

Observational studies by Oller (1973) and Panagos (1974) suggest that the phonological development of language disordered children follows that of normally developing but younger children. However, Oller and Panagos used distinctive feature notation in their analysis of data. To date no quantitative data from an acoustic analysis of speech production which examines the phonological development of language disordered children as it relates to the timing dominant mechanism has been reported.

In a preliminary study by the authors, an acoustic analysis was used to examine the productive use of /l/ consonant clusters in language disordered and normal children. This analysis revealed a significant discrepancy in the duration of the clusters between the two groups. While the subjects were age-matched, the language disordered children required two to four times as much time in msec. to articulate the /l/ cluster words as was needed by the normal subjects.

On the basis of this data, a decision was made to enlarge the scope of

the study: to examine younger normals, those who were acquiring the productive use of /l/ consonant clusters, and to compare their durations with those of the language disordered children who were also acquiring the productive use of these clusters. The specific objectives of this study were (1) to use an acoustic analysis of speech production to examine the Oller hypothesis of normal phonological developmental patterns in language disordered children, although at a later chronological age, (2) to determine the developmental period over which the disordered children use increased duration as a continued strategy, and (3) to document any additional productive strategies which may be used by the disordered children.

Procedure

The experimental subjects were eight severely language disordered children, ages 6-2 to 8-7 who attend the aphasic unit of a school for the deaf in Massachusetts. The children had no hearing deficits and had normal non-verbal intelligence according to their evaluation records. They did not exhibit any serious emotional disturbances. Articulation skills were assessed using the Goldman-Fristoe Test of Articulation.

The control subjects were eight normally developing children, ages 2-10 to 4-10, intentionally not matched in age with the language disordered children. They were in the process of acquiring the productive use of initial consonant clusters. Receptive and expressive language skills were measured on the Zimmerman Pre-school Language Scale. All children performed at average to above average levels in language functioning.

Fifty-six monosyllabic English words were selected as stimuli. There were 20 words with initial consonant clusters /pl/, /bl/, /kl/, /gl/, and /sl/; 20 words with initial /p/, /b/, /k/, /g/, and /s/; and 16 words with initial /l/. Cluster initial and singleton consonant words were matched. For example,

if the word for the initial consonant cluster /b/ was black, the singleton /b/ and /l/ words were back and lack. The stimulus words met the following criteria: (i) monosyllables, (ii) meaningful (real English words), (iii) (c)vc structure, and (iv) contained the vowels [ɪ] [i] [ɛ] [æ]. Stimulus words are presented in Table 1.

The stimulus words were randomized for presentation to the subjects who were tested individually. The examiner asked the subjects to repeat the frame sentence "Say _____ now", inserting the stimulus words into the slot. This was done to minimize the effects of pre-pausal lengthening in the utterance final position. The subjects repeated the entire sentence after the examiner.

Data was collected in a sound treated room in a single session. A Revox reel-to-reel tape recorder, Shure uni-directional lavalier microphone model #5451 on a stand, and 3-M Scotch Low-noise Dynarange tape were used in the data collection.

The data was analyzed in the following manner. Spectrograms were made of the stimulus words on a Kay Elemetrics Sonograph, Model #6061B, with a high frequency boost. Following procedures described by Menyuk and Klatt (1975), measurements were made of the durations of the /l/ consonant clusters. Measurements were also made of the durations of each separate element of the cluster, and these elements in the initial position as singletons in the monosyllable words. A total of 720 spectrograms were made, of which 522 could be used for analysis. The spectrograms rejected were judged unreadable because the subjects spoke too softly at the time of the taping, resulting in a spectrogram of poor quality.

Results

We present here the results of the measurements of the /l/ consonant clusters, comparing the normal subjects and the language disordered population.

Included in the graphs are data on normal adult /l/ consonant cluster production from Klatt (1975). That data was obtained and measured using the same procedures as the present study, thus permitting these comparisons.

Age is indicated along the X axis and the duration of the clusters in milliseconds along the Y axis. The open circles indicate the mean durations of the cluster production of the normal subjects; the closed circles, the mean durations of the language disordered subjects; and the "x's", the durations of the normal adults (from Klatt, 1975). The dashed lines indicate the range of duration within which most of the normal control subjects fell. This provides for a frame of reference from which to evaluate the durations of the clusters of the language disordered subjects and the adults. These data are presented in Figures 1 through 5.

Discussion

The normal children's /pl/ cluster production, Fig. 1, ranged from 133-206 msec., as did that of the disordered children, with one exception. For this child there was only one /pl/ token available for analysis. The child appeared to have produced the /p/ as /b/ (as perceived by the experimenters). It is possible that the child's exaggeration of duration may be the result (or outcome) of his difficulty in producing the +V/-V distinction in the usual time domain. The duration of the adult production of the /pl/ consonant clusters is an average of 61 msec.

The duration of the normal children's /bl/ cluster production ranged from 65-140 msec., Fig. 2. The disordered children's /bl/ cluster production fell into the same range as the normals with the exception of two subjects. These high average durations were the result of the splitting of the cluster and the insertion of the schwa, which excessively lengthened the duration of the cluster production of these children. The duration of the adult production

of the /b/ consonant clusters is an average duration of 13 msec.

In the /k/ cluster data, Fig. 3, all the normal children ranged from 130-220 msec. The disordered children ranged from 125-200 msec., with three exceptions. Two subjects indicated elongated patterns in excess of 200 msec.; one subject a very short duration as a result of the deletion of the /l/ of the cluster. The mean duration of the adults was 77 msec. This compares with the mean of 75 msec. for the 6½ year old normals in the pilot study.

All the normals, with the exception of one child, produced /gl/ clusters ranging in duration from 80-180 msec. (See Fig. 4.) This child was the youngest of that population and completely distorted the stimulus word in the sentence. He produced /glæ s/ as /pæ s/. By contrast, the disordered children's durations covered a much wider range. The increased durations of both the /g/ and /l/ contributed to these lengthy productions. The adult's average duration is 26 msec.

For the /s/ cluster data, Fig. 5, all but one of the normal children's durations ranged from 270-380 msec. All of these durations were the result of the splitting of the cluster and insertion of the schwa. Four of the disordered children fell within this range; the remaining four subjects ranged from 190-260 msec. While one might be led to hope that this suggests production approaching normalcy, examination of the spectrograms revealed /l/ deletion, or distortion of the time frame of the sentence, as the causes for the reduced duration. There was no /s/ cluster data from Klatt. He did collect information from eight other /s/ consonant clusters, including triple clusters, e.g. /skw/. The range of durations of these clusters was from 8-48 msec. None of the children from either population were approaching the adult values.

According to Gilbert and Purves (1977), the duration of consonants in a

cluster is known to be reduced relative to the duration of the same consonants as singleton segments. In other words, in normals the sum of the duration of the cluster is less than the sum of the duration of the same consonants as singleton segments. For example, the sum of the duration of /sl/ in sled will be less than the sum of the durations of the /s/ in said and the /l/ in led. Analysis of our data revealed that 78% of the normal subjects adhered to this pattern, while it was true for only 60% of the language disordered subjects. See Table 2 for mean durations of singletons for normal and language disordered subjects.

Further examination of the spectrograms indicated that the language disordered children were using productive strategies not used by the normals in this study. One of the most used strategies was: "Get my tongue in the right place and then I'll say the word". One subject used this strategy with velar consonants in the initial position: glass, class, and clap in the clusters. Other subjects used this strategy with bilabials: bless, play, and back. Both consonants of the cluster were clearly produced, but lacked a smooth synthesis of the cluster. Additionally, the epenthetic vowel /ə/ was not present in the spectrograms. This strategy may be the outcome of a teaching strategy of the school. Another strategy was collapsing segments. "Pay attention to something at the beginning of word #2 and to something at the end of word #3". In the frame sentence, "Say glad now", this strategy was realized as, "Say lao^w", while "Say clam now" was "Say keeo^w".

One fact became increasingly evident as we listened to the children and then examined the spectrograms: our own phonological systems tended to normalize what we heard. Spectrographic analysis of the speech of those language disordered children who sounded most like normals indicated that their productions were very dissimilar. Comparisons of the same words of the normals and lang-

uage disordered indicated marked dissimilarities in clarity of transitions and in vowel formants.

Summary

This study has addressed three issues in the phonological development of normal and language disordered children. The hypothesis that the phonological development of language disordered children follows that of normally developing, but younger children is partially supported in that both groups use the processes of deletion, splitting, and elongation. However, the data also support the fact that the language disordered continue to lengthen clusters with the above devices long after normally developing children have ceased to do so. Finally, this study has documented the use of productive strategies not evident in the production of normal children in this study. Some remaining questions are: 1) Do normally developing children younger than 2-10 engage in the individual productive strategies of the language disordered children? 2) At what point do language disordered children begin to demonstrate durations approximating adult-like durations? and 3) Do the disordered children ever attain adult production durations of consonant clusters?

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TABLE 1

STIMULUS WORDS

bleed	bead	lead
bless	bess	less
black	back	lack
plea	pea	lee
play	pay	lay
plane	pane	lane
place	pace	lace
planned	panned	land
glass	gas	lass
glad	gad	lad
clean	kean	lean
class	cass	* lass
clap	cap	lap
clam	cam	lamb
sleep	seep	leap
sleek	seek	leak
sleigh	say	* lay
sled	said	led
slap	sap	* lap
slam	sam	* lamb

TABLE 2

Mean duration of singletons produced by Normally Developing Children and Language Disordered Children

Normal Subjects

	/p/	/b/	/k/	/g/	/s/	/l/
#1	9	86.6	113.3	50	206.6	151
#2	10	113.3	273.3	20	225	186.6
#3	8.3	-----	140	-----	-----	200
#4	4	86.6	86.6	25	243.3	138
#5	8.3	120	150	15	180	128
#6	-----	-----	106.6	-----	196.6	122.5
#7	5	86.6	100	15	200	101
#8	40	100	45	-----	-----	94

Language Disordered Subjects

	/p/	/b/	/k/	/g/	/s/	/l/
#9	30	46.6	71.6	70	181.6	82
#10	10	73.3	53.3	25	173.3	66.6
#11	40	30	46.6	30	233.3	101.6
#12	24.3	173.3	166.6	110	266.6	125.8
#13	33.3	93.3	160.6	35	310	140
#14	8	83.3	96.6	60	183.3	185
#15	8	71.6	131.6	20	256.6	115
#16	15	60	88.3	30	140	148.3

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Figures 1 - 5. Mean durations of consonant clusters in milliseconds by normally developing children, language disordered children, and normal adults (from Klatt, 1975).

- - normally developing children
- - language disordered children
- # - Klatt, normal adult subjects

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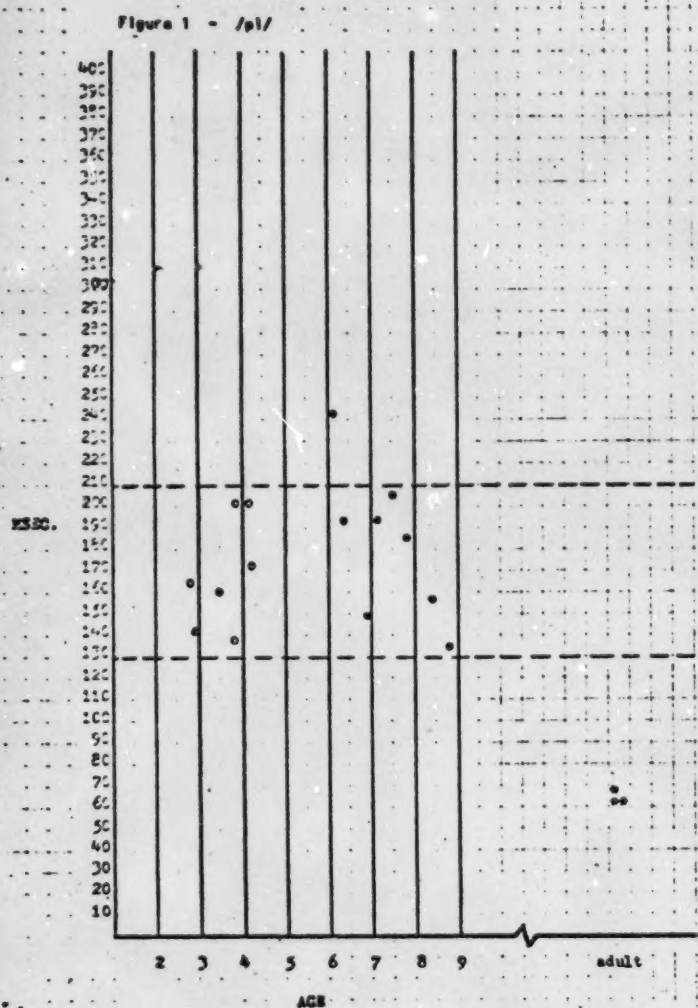
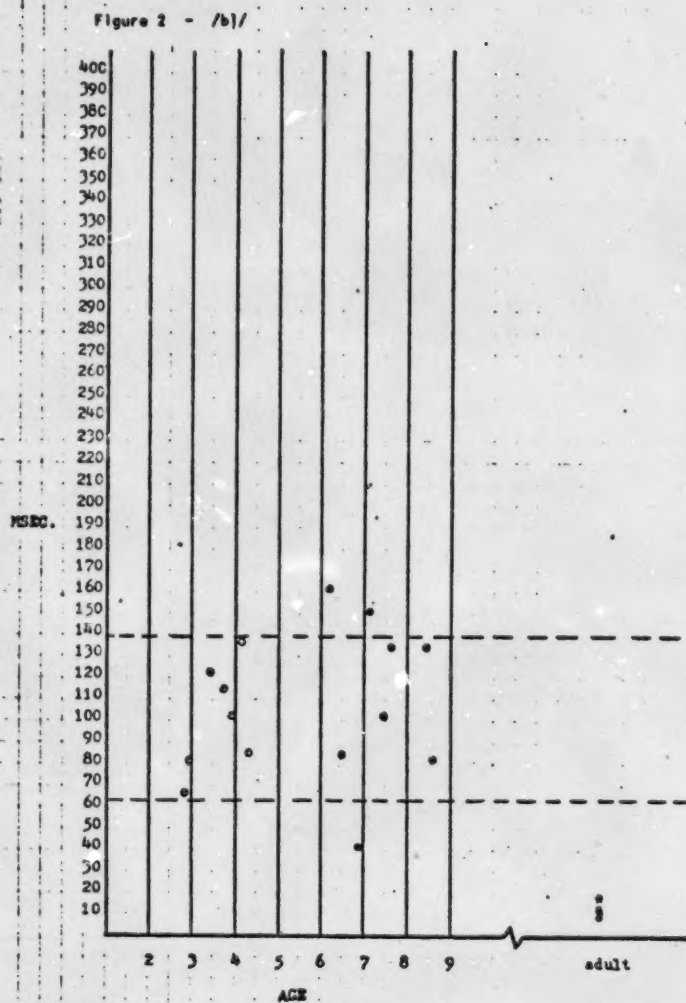


Figure 3 - /k/

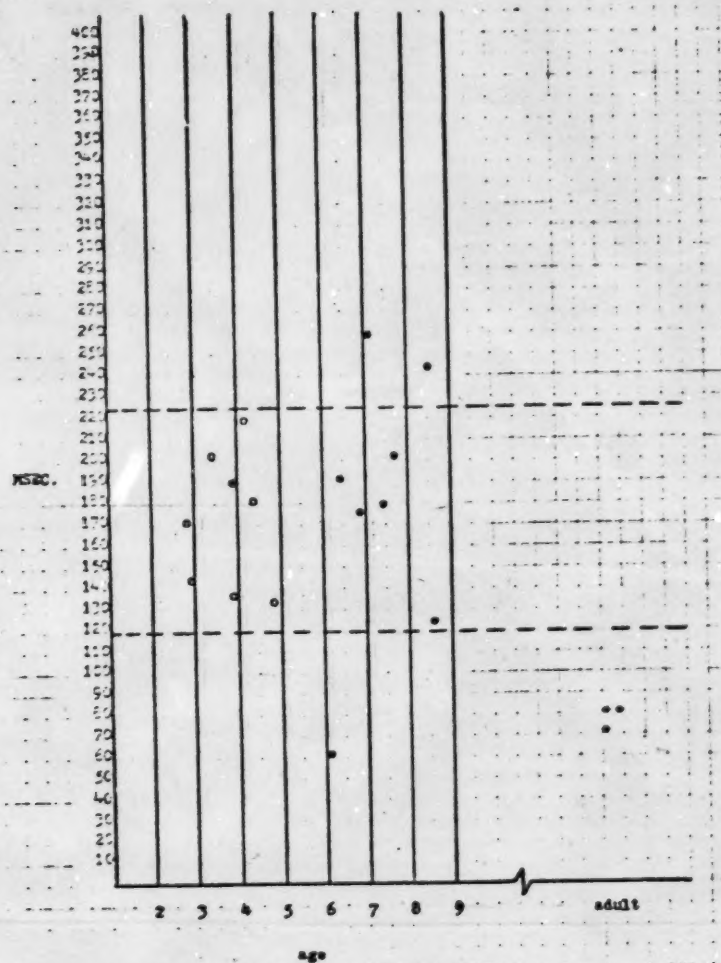
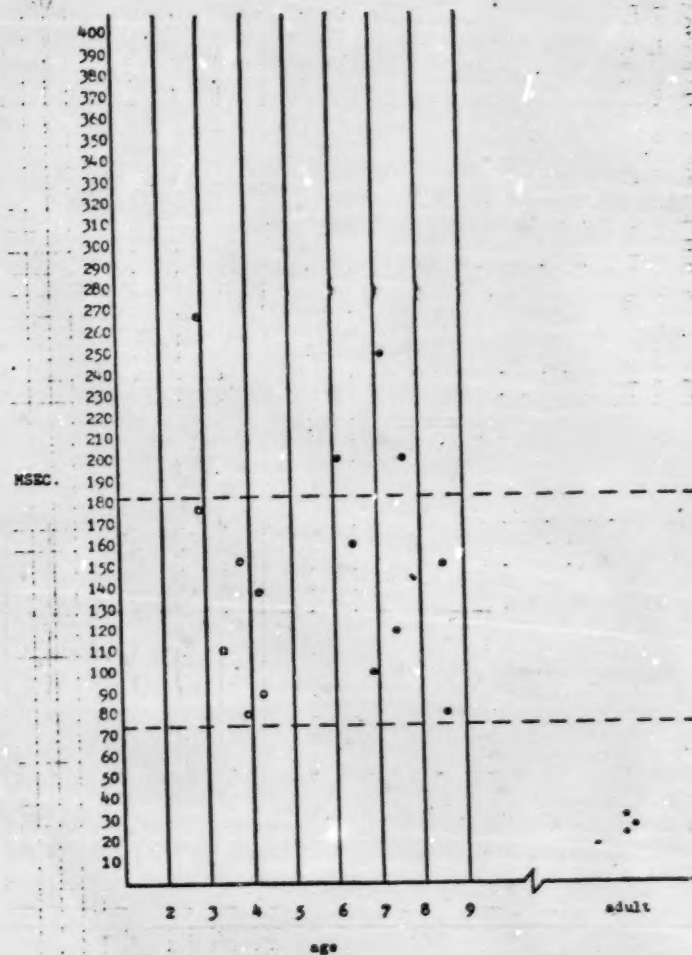
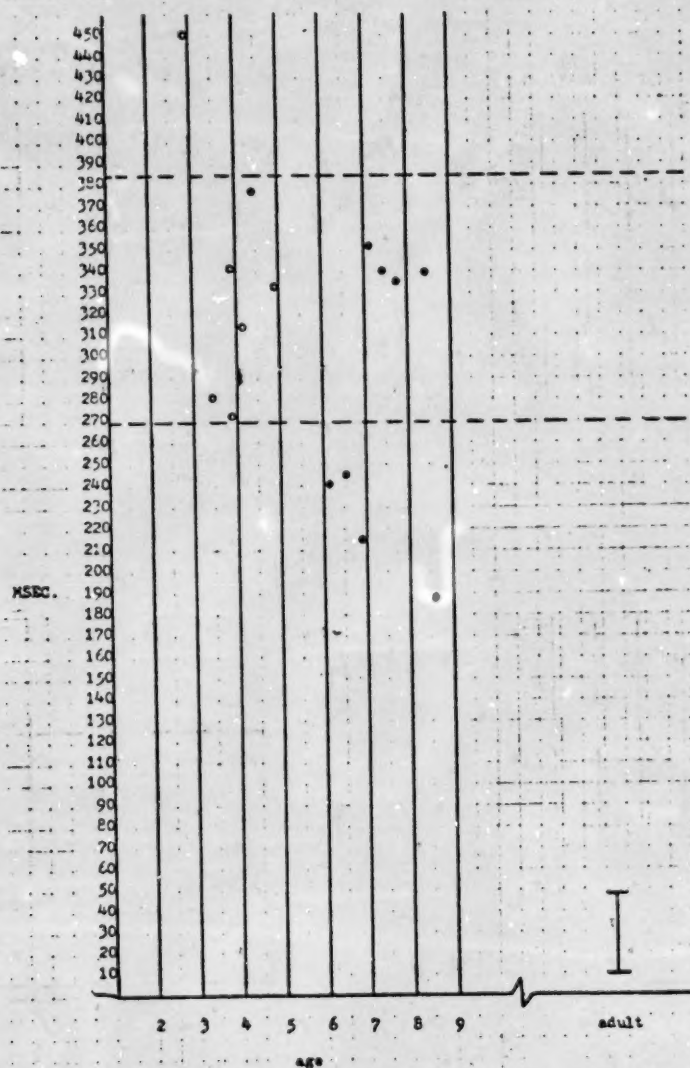


Figure 4 - /g/



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Figure 5 - /s/



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